VOLUME 34, NO.4 • THE GEORGE WASHINGTON UNIVERSITY • EDITION 2, WINTER 1988

MECH ENGR CIV

CROSSING THE GAP BETWEEN MEDICINE AND ENGINEERING

PUBLISHED BY THE ENGINEERS' COUNCIL IN COOPERATION WITH THE ENGINEER ALUMNI ASSOCIATION

VOLUME 34, NO.4 • THE GEORGE WASHINGTON UNIVERSITY • EDITION 2, WINTER 1988

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COVER: Due to innovative medical technology, Doppler imaging techniques permit doctors to see "movies" of a beating heart in real time, allowing doctors to easily pinpoint problem areas such as a leaking valve.

Acupuncture — An Ancient Practice

7

by: Dieu Nguyen

Acupuncture, an ancient art has now become a pin pointing reality! Read about how this meridian theory has advanced from ancient healing techniques to today's electro-acupuncture. Yet, despite the positive results, acupuncture is still considered "just an antique mythology".

Applications of Recombinant DNA Technology

10

by: Ha T. Huynh

A common fly has a leg growing where a wing should be . . . what caused this strange deformation? Find out more about this and how other engineering genetic engineering wonders can help us.

Medicine and Technology Working Together

12

by: Rose Province

A small heart shaped icon blinks in time to the beat of a infant's heart, a waveform blips across the screen and breathing rates are continuously indicated. Without this medical engineering technology that carefully monitors an infant's vital signs, and controls heat and oxygen intake, these infants would probably not survive.

Departments

Tech Briefs . . . 4
Campus News . . . 14

Student Professional Awareness Conference

IEEE THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

The George Washington University

Wednesday, March 2, 1988 • 2:00 - 9:30 pm

Marvin Center, 800 21st Street, NW, Washington, DC

Program

Dorothy Betts Marvin Theatre,
Marvin Center, 1st Floor:

2:00	Welcoming by Dean of SEAS, Dr. Harold Liebowitz
2:10	Larry Dwon: "The Art of Becoming Employed"
3:00	Cecelia Jankowski: "Engineering as a Profession: Expectations and Reality"
3:45	Refreshment Break
4:10	Charles Alexander: "Should You Try For An Advanced Degree?"
5:00	Hans Cherney: "Engineering Professionalism and the IEEE"
5:45	Break
6:00	Panel Discussion on Professional Licensure and Registration
7:30	DINNER at Marvin Center Ballroom (Reservations must be made by February 17, 1988)
8:30	Special After Dinner Guest

SPAC Conference/Dinner Reservation Form

Cut or make photocopy of and send in envelope to:

IEEE Student Branch (SPAC)
EE/CS Dept. of SEAS, The George Washington University
801 22nd Street, NW, 6th Floor
Washington, DC 20052

Please print:

Name: _____

Local Mailing Address: _____

_____

Year: _____ Major: _____ Phone: _____ GW ID: _____

Please indicate ticket(s) desired:

[ ] New half-year IEEE Student Membership $8.50
(Includes free tickets to conference and dinner)

[ ] Current IEEE Member (Indicate membership number: _____)
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- [ ] Dinner Ticket $5.00

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Please make checks payable to IEEE. Payment enclosed $ _____

For more information, please contact Ka Lee at (202) 842-2547 or Carmen Kocinski at (202) 994-6083.

Metamorphosis of Engineering Students

Introducing . . . Student Professional Awareness Conference(SPAC) March 2, 1988

by Carmen Kocinski

Let me introduce you to the crucial metamorphosis of engineering students as they become engineers, and to the Student Professional Awareness Conference planned for all engineering students, national and international, at G.W.. The George Washington University School of Engineering and Applied Science performs a miracle of modern education. Incoming students who have minimum wage earning power upon their high school graduation are transformed after four or five years as successful SEAS students . . . . SHAZAM! They are hired in an engineering position. Their professional careers begin.

To emphasize the significance of this transition from student to engineer, let's look at it from the salery point of view. Minimum wage is about $10,000 a year. Our sophomores graduating in 1990 may see starting salaries of $36,000 a year and a career peak salary of $75,000. There is a profound assumption on behalf of the employer. That is that you have absorbed perfect knowledge of the technical area in which you have your degree. Of cource this is very difficult to measure. Howere, the Accreditation Board for Engineering and Technology (ABET) having approved the particular programs at G.W. assure the employer of some standards in the educational process.

IEEE

THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Beyond the fundamental technical knowledge is the field of engineering as a profession. There are registration procedures and licensing of engineers much like the registration and licensing of medical doctors and lawyers. The titles are Engineer in Training(EIT) and the Professional Engineer(PE). There are professional practices and ethical and social responsibilities associated with the positions held as an Engineer. The actual process and importance of registration is worthy of another article. Interested students may look for meetings on campus of the newly formed G.W. student chapter of the National Society of Professional Engineers(NSPE).

If the metamorphosis of engineering students includes professionalism then how do our students learn professionalism? There is a message in my SHAZAM above answering this question. The letters stand for School, Honors, Activities, Zeal, Application and Mentorship. In school you get your first impressions of the field of engineering from the role models of your professors, and especially from your advisor who guides you into the field

Student
Professional
Awareness
Conference

academically. Through honors conferred by the school and participation in the Honor Societies stuents are recognized for their outstanding academic performance. Getting involved in the activities sponsored by the student engineering societies encourage student interaction with their peers. Activities also include attending technical meetings, entering competitions and taking an active role or leadership position in the student organizations. Zeal for the engineering profession is like a passion for the creativity of solving real life problems with the application of todays technologies. Application of you abilities to such problems is a learning process in school and out. Mentorship in the workplace is where you advance in your career by support and advice of superiors.

The Student Professional Awareness Conferences(S-PAC's) promote engineering as a profession to all engineering students. S-PAC's fit in the activities category above. This is an official conference sponsored by the Institute of Electrical and Electronics Engineers (IEEE) which is a non-profit, worldwide professional organization. While all of the student engineering societies, Engineers Council and engineering honor societies at G.W. are actively supporting and promoting the S-PAC'88 to be held in the Marvin Center Theater on March 2nd, correct attribution must be given for the origination. Please allow me. IEEE works through the USAB (United States Activities Board) Professional Activities Council and the RAB (Regional Activities Board) Student Professional Activities Committee. The success of over 300 S-PAC's world wide since 1979 attest to their accomplishment of filling a need. Successful S-PAC's have averaged 300 students while some have drawn as many as 700.

S-PAC's are generally a one afternoon session with a banquet in the evening. National speakers give talks on what to expect on the first job, career planning, professional ethics and career enhancement through professional involvement. A panel discussion late in the session often leads to lively debate. Students may field questions of the panelists. Topics for this portion include issues like changing engineering programs to five year degree programs, or schools actively promoting licensing by requiring students to take and pass the EIT exam to graduate.

The IEEE Student Branch and it's S-PAC committee do all of the work in organizing the event. The arrangements for facilities, speakers and the publicity and ticket distribution take a tremendous coordinated team effort. The success of the S-PAC is in a large measure dependent on the support and encouragement of the administration and faculty of the school. Experience has demonstrated that a large attendance is a factor of the number of students normally present at school on the day scheduled for the event. Recognizing that schedule conflicts can reduce attendance significantly, the IEEE Student Professional Activities Committer Members encourage cancellation of all engineering classes, and that the Department Heads endorse this activity as an educational component in promoting engineering as a profession. We have asked the Departments for accomodation of class absenteeism in a statement presented to the Department Heads last semester. The statement reads as follows:

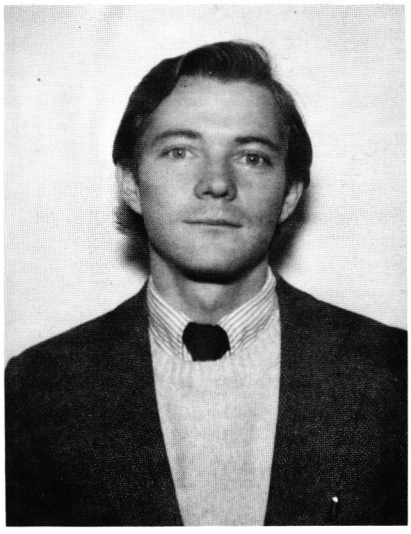
That accomodation be made in the form of an "easement" declared by the school and made to suit each course instructor's situation with consideration of the interest of the students. Easement may take several forms:

a)No exams on the event day, and homework due later. b)Minimum coverage of material. c)Informal arrangement to reschedule class time or make up time, and require verification of attendance at the conferance.

The above applies to S-PAC officers and volunteers for the entire day.

The easement if implemented may take a different form for each class. Each department Head has indicated a general support for the S-PAC already. It is important however that the students speak up in class if an instructor neglects to bring up the subject of the S-PAC attendance. Remember, you do not have the right to attend, it will ultimately be the policy of the individual instructor if you have a class at that time. This event is strongly recommended for all Senior and Junior Engineering students. While all others, including Freshmen and Graduate students are welcome, they need not be militant about having their professor of a Wednesday class make it easy for them to attend.

Remember, the beginning of your career is the day you decided to be an engineer, but you do not become an engineer until the day everyone else decides you are one.



EULER UY

Carmen Kocinski is a candidate for the MSEE degree in the communications program at George Washington University. He received his BSEE in 1985 from the University of Alaska at Fairbanks where he was active in the IEEE. Carmen was a recipient of the 1987 Outstanding Student Member Award conferred by the IEEE National Capital Area Council. He has been active in the Washington section of IEEE, particularly with the PACE sponsored workshop "Careers-Phase II." Carmen is also a member of Eta Kappa Nu.

Cell Transplant as Disease Control

Through a new surgical technique, physicians and surgeons have new hopes of controlling a disease that affects an estimated one million Americans. This illness is called Parkinson's disease, which is named after James Parkinson, who wrote a classic essay in 1817 about this "shaking palsy". This progressive neurological disorder is due to a deficiency of a chemical in the brain called dopamine. Dopamine carries messages between nerve cells in the brain, influences the initiation and modulation of movement, and regulates the unconscious automatic movement.

The three major symptoms of Parkinson's disease are tremors, rigidity or muscle stiffness, and slowness of movement (bradykinesia). The first sign, tremor, affects handwriting and is aggravated by emotional stress. The second characteristic, muscle stiffness, results in muscle soreness, and pain in the head, upper body, spine or legs. The third evident symptom, bradykinesia, leads to loss of automatic movements, stooped posture, and shuffling gait.

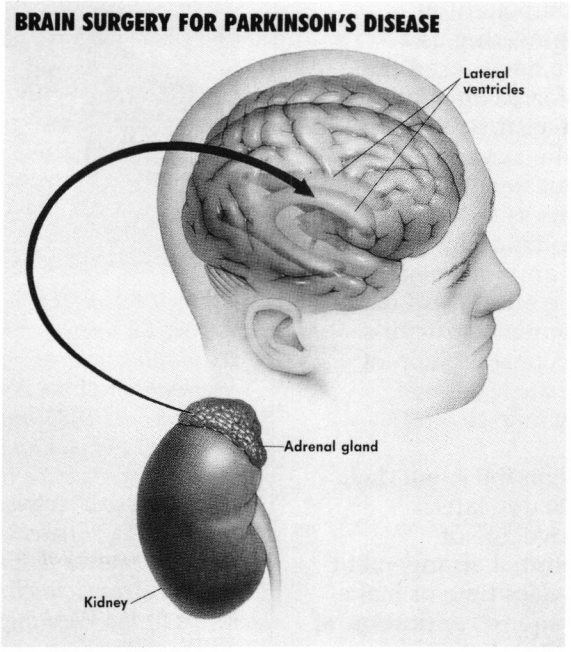
These symptoms occur most commonly after the age of fifty. The cause of Parkinson's disease is still unknown, although its symptoms have folllowed some chemical intoxications of carbon monoxide and manganese (especially among coal miners). There is no apparent genetic cause. Thus, medical management is aimed at relieving the symptoms, since there is no known cure for the disease.

A surgical technique developed by Navarro Madrazo, chief of neurosurgery in Mexico City's La Raza Hospital, seems to solve the problem of the disease's deficiency of dopamine. Doctors have always known that the adrenal grand, which lies above the kidney, secretes dopamine that cannot reach the brain. So, by transplanting these secreting adrenal cells into the brain, the symptoms of ill patients could be reversed.

The first attempts to implant the adrenal cells near the region where dopamine is normally produced in the brain gave disappointing results. The reversal of symptoms did not last long in the patients, because the adrenal cells died due to lack of nutrition. However, with the help of Rene DruckerColin at the University of Mexico, Madrazo transplanted the adrenal cells in a brain cavity, bathed with nutritive cerebrospinal fluid, where the cells could thrive better.

Physicians still have to consider the physical difficulty of a safe operation on people who are already severely affected by the disease. Yet, its success has attracted the attention of Muhammed Ali, who has the disease due to blows to the head from boxing. It will still take several years to "see what has transpired in people's brains," but it looks like the medical profession is coming very close to perfecting a solution to the dehibilitating disease called Parkinson's disease.

— *Lilimar Z. Avelino*



The adrenal gland, lying above the kidney secretes the chemical called dopamine, that Parkinson's disease victims require in the brain. By transplanting adrenal cells into the brain, the symptoms in patients can be reversed.

Jupiter, Here We Come!

NASA has been under growing external pressure to announce plans for a new shuttle program since the explosion of the Challenger nearly two years ago. In early December the space agency publicized plans for its long awaited Galileo Mission to Jupiter.

The mission, which was first scheduled for 1982, has an approaching launch window which will extend for six weeks in the fall of 1989. However, in order for the launch to take place the budget problems which now face the shuttle must first be solved.

Since 1982, Galileo's path after being launched from the shuttle, has been redesigned. Included in the 1989 Galileo mission are two loops of Earth and Venus by the spacecraft, before continuing on to Jupiter. The two loops are needed in order for Galileo to gain momentum, from the gravitational fields of earth and Venus, for its flight to Jupiter. The rocket that was originally supposed to boost the spacecraft from its cargo bay proved to be hazardous and had to be replaced by the safe solid-fuel booster. Hence, the looping flight-plan will be used.

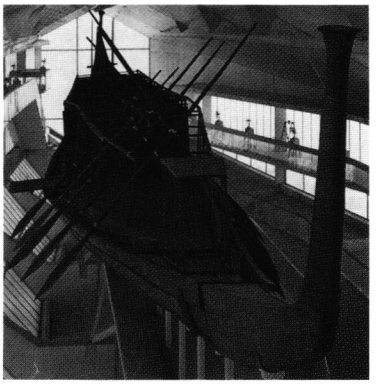
The new flight-plan is scheduled to take the spacecraft within close range of the extremely hot atmosphere of Venus, therefore the spacecraft Galileo for 1989 must sport a new feature. The craft is coated in extra sheets of gold in order to protect it from the high temperature atmosphere of Venus.

The un-manned mission which is scheduled to last eight years and cover 2-3 billion miles, is expected to provide the scientist with a wealth of information on the planet Jupiter, its moons, and atmosphere. While on its extended voyage Galileo is also expected to pass within 620 miles of the asteroids GASPRA and IDA in October of 1991 and August of 1993, respectively.

Around the middle of 1995 the spacecraft will be on its final approach to planet Jupiter and will release a probe. The probe will be the first earthly object to penetrate the gaseous atmosphere of the planet. Its instruments will relay information to scientists until it is overcome by Jupiter's atmospheric pressure. The transmission of data is expected to last approximately 75 minutes.

The spacecraft is then scheduled to orbit Jupiter for two years. During this time the spacecraft will gather information on the planet and four of its moons. The data obtained from the mission will then be studied and analyzed by NASA scientists. This data will do much to further our understanding of our planet and our universe.

—Joy Rogers



TIME

The reconstructed sister ship of Khufu.

A Piece of the Past . . .

In the early hours of the morning in late October, modern technology made it possible for scientists to peek into the distant past. A miniature camera was lowered through a small hole into a sealed chamber in the Great Pyramid at Giza, Egypt, built by the Pharoah Khufu 4,600 years ago. For the curious scientists, the chamber revealed the dismantled timbers of a royal ship! Scientists had long suspected the existence of this ship ever since they discovered its sister ship in 1954, near the tomb of Khufu.

To scientists the ancient air was just as important as the other items in the chamber, so a method was found to peer into the chamber with the least amount of intrusion from the 20th century world outside. Bob Moores of Black and Decker devised a drill with a novel air lock seal. As the drilling began, the dust particles were swept up with an industrial vacuum cleaner. The process took three days to complete, as scientists drilled an inch at a time. Then a miniature remote-controlled video was inserted into the three and a half inch wide hole. The camera provided fiber-optic light without introducing heat into the chamber. As the scientists gazed into the monitor they saw what seemed to be a pile of lumber under reed matting. But they quickly realized it to be the long sought sister boat of Khufu.

No immediate plans have been made to excavate the chamber, so scientists resealed the hole after completely filming the interior. With the film scientists hope to determine the size of the ship and maybe its purpose as well. Many believe the ships were made to carry the spirit of the deceased on his eternal journey around the earth with the sun god Ra. While others believe the ships were simply used to carry the body of the pharoah across the Nile for burial. Whatever the find, the newfound chamber should offer scientists a greater incite into a world 4,600 years in the past, all possible through the engineering technology today.

— Vaiji Ramaswami

Biomedical Engineering Today

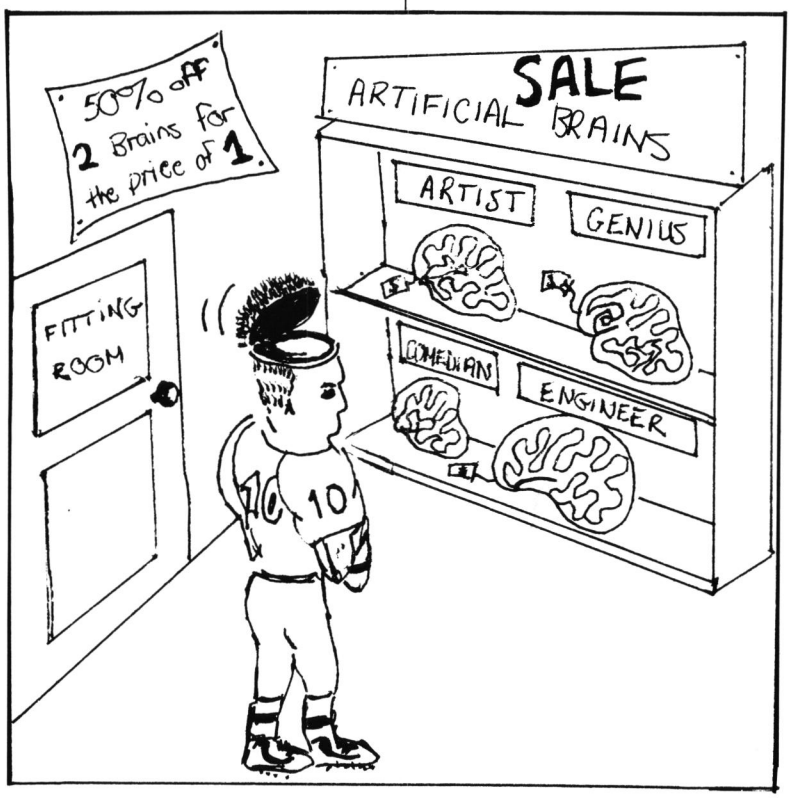
Over the past forty years a technological revolution has occured: the application of engineering in the field of medicine. This result arose from the realization that certain disciplines outside of medicine can help in the betterment of its practice.

One way to define bioengineering is the application of well established engineering principles, concepts and techniques to the world of living systems. The application of engineering to living systems is a relatively new field that has two unusual characteristics.

The first is that the activity field is large — it encompasses at least the whole of medicine and the whole of engineering combined. Engineering technology involving living systems become quite complex, thus challenging both the endeavors of the medical doctor and the bio-engineer.

Direct interaction of individuals trained in the fields of medicine and engineering has allowed us to realize the beneficial elements of teamwork. This teamwork between the medical and engineering disciplines, better known as bioengineering, has branched off to create many fields of interest, four of which are the following:

- BIONICS - the study of engineering mechanisms of the biological process and their applications in engineering.



- APPLIED BIOLOGY - the application of the biological processes on an industrial scale.

- BIOMEDICAL ENGINEERING - applications of engineering to medicine in two categories: (a) the study of the human body in health and disease, (b) development of engineering instrumentation and devices for medical research and practice.

- ENVIRONMENTAL HEALTH ENGINEERING - engineering of the environment in closed and open systems to ensure the health and comfort of the inhabitants.

The four fields cover a sufficiently large range of activities to keep any engineer that is attracted to the bio-field fully satisfied during his/her active career. This edition emphasizes biomedical engineering through articles dealing with DNA research, instrumentation , acupuncture techniques . . .

So sit back in your favorite chair and enjoy as we travel through the wonderful "world" of biomedical engineering.

For the interested reader, more information on the various aspects of bioengineering can be found in — BIOMEDICAL ENGINEERING by: R. M. Kenedi published by: Blackie and Son Limited, 1980

—Tom Kee
Thang Q. Le

ACUPUNCTURE - AN ANCIENT PRACTICE

by Dieu Nguyen

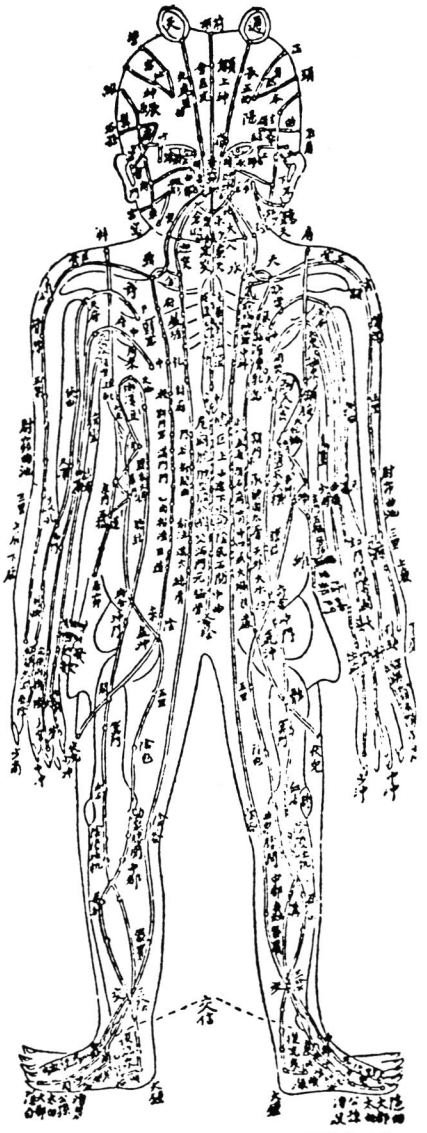
Those days thou hast and their adoption tried
Grapple them to thy soul with loops of steel
But do not dull thy palm with entertainment
Of each new watch'd unfledged remedy.

To many unbelieving westerners, acupuncture **is** the unfledged remedy of which Polonius speaks of in *Hamlet*. However, the Chinese practitioners, with several milennia of practical experience, has proven acupuncture to be more than just part of the mysterious and sometimes spurious Eastern lore. In fact, for thousands of years, favorable results have shown acupuncture to be a very effective treatment for pain and various other diseases. Acupuncture is not only accepted as a branch of medicine by the Chinese, as well as by many other European and Eastern countries, but is also one of the principal ingredients of Chinese medicine. Even in the United States, the World Health Organization recognizes its use for at least forty conditions.

ACUPUNCTURE - A 3000-YEAR-OLD REMEDY

Acupuncture (derived from the words *acus*, meaning "needle," and *pungere*, meaning "puncture") is not the sole possession of the Chinese. It can be traced as far back as the Stone Age, when stone knives and other sharp edged tools were not only invented to meet the needs of production, but were also used to relieve pain and treat diseases. These instruments, known by the ancients as "bian," may represent the most primitive acupuncture method. A form of acupuncture may also have been known by the ancient Egyptians. The papyrus Ebers of 1550 B.C., the most important medical treatise of the ancient Egyptians, referred to a book on the subject of *vessels* which could correspond to the twelve meridians of acupuncture. The Chinese, however, is accredited for the greatest contribution to acupuncture in that they have developed a fairly systematic method. They have also established the *chinglo*, or meridian theory of body physiology which attempts to explain how acupuncture works.

According to the meridian theory, the body consists of hundreds of points (acupuncture points) that are connected by twelve paired and two unpaired bilateral imaginary lines called meridians. On each of these meridians, there exists exactly the same number of acupuncture points. Six of the paired meridians consist of "deep" internal organs called *Yin* while the other six consist of "hollow" internal organs called *Yang*. *(See Fig.1)* The twelve main meridians are supposedly connected in a specific order and direction so as to allow a life force *Qi* to flow through them in 24-hour cycles, keeping a balance between the *Yin* (positive) and the *Yang* (negative) forces. Illness occurs when the *Yin* and *Yang* are out of balance, that is, some



COURTESY OF AMERICAN JOURNAL OF CHINESE MEDICINE

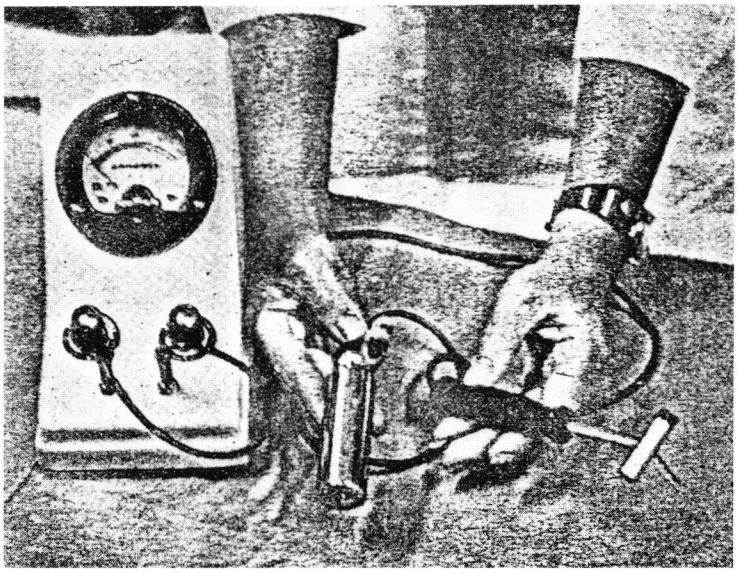
FIG. 1 — Ancient acupuncture chart showing the meridians and points.

organs have an excess amount of *Qi* while other organs are *Qi*-deficient. Acupuncture can then be used to restore the balance between the *Yin* and the *Yang*. This can be accomplished either by needling or applying a mild electric current to certain acupuncture points corresponding to the defective organs.

ELECTRO-ACUPUNCTURE

The method of applying an electric current to the acupuncture points is often referred to as electro-acupuncture. It is a relatively new method which was first applied in the 1950s. The concepts applied to electro-acupuncture are the same as those applied to the hand-manipulated method of needling. The only difference between the two methods is that one uses hand-maneouvered stimulation while the other uses electrical stimulation of the acupuncture points. The method of electro-acupuncture has some advantages over the traditional method in that it can produce a stronger stimulation. Also, the amount of stimulating force can be adjusted more accurately by adjusting the electric current applied to the acupuncture needles. This current, usually in the form biphasic spike waves, can be generated by a small stimulator attached to the acupuncture needles already in place.

One example of such a stimulator is the Chinese 626, a portable battery-powered electrical stimulator applied to the skin through flexible conductors and miniature electrical clips attached to the acupuncture needles. This instrument has two main controls over the output: a five-position pulse modulation selector and a variable potentiometer for pulse amplitude or intensity. *(See Fig. 2)*



COURTESY OF ACUPUNCTURE FOR PHYSICIAN

FIG. 3 — A typical neurometer used to measure the skin resistance of acupuncture points.

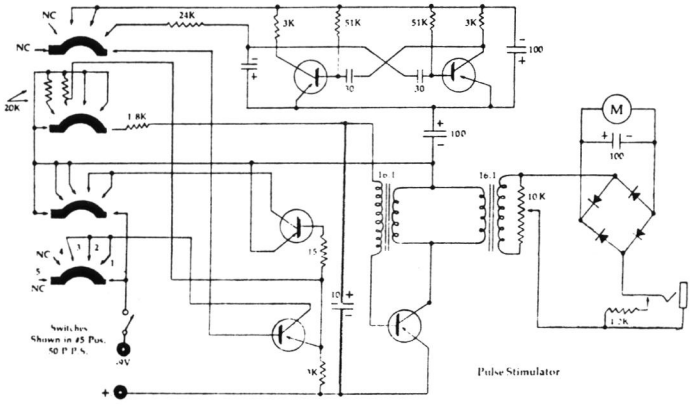
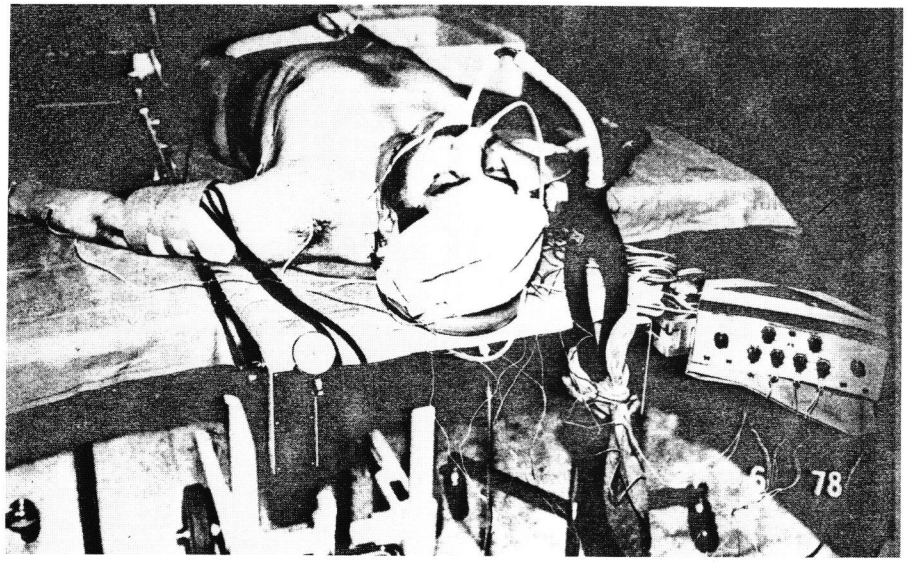


FIG. 2 — Schematic for the Chinese 626, one of the many types of stimulators used in electro-acupuncture.

Also relatively new to the acupuncture horizon is the method of locating acupuncture points electrically. The acupuncture points are identified by noting the decrease in electrical resistance over an area compared to the resistance of the surrounding skin. The electrical resistance over the various areas can be measured by passing the pencil probe of a neurometer over those areas. *(See Fig. 3)* In the same individual, the electrical resistance of each acupuncture point on the same meridian may vary. *(See Fig. 4)* Some research has also found that, at these sites or points, the audio-frequency conductivity and the electrical potential of the skin is greater than at the surrounding tissues.

ARGUEPUNCTURE - THE CONTROVERSIES

For decades, acupuncture has been the center of numerous controversies in the western world. Because acupuncture lack a complete, western-style scientific explanation for how it works, many western physicians tend to reject the entire method, despite the favorable results. In the eyes of the western world, the meridian theory, upon which acupuncture is based, is merely "an attractive system of antique mythology, laced with poetry and tradition."



AMERICAN JOURNAL OF CHINESE MEDICINE

FIG. 5 — Patient with acupuncture needles in place, ready for electro-acupuncture therapy.

In recent years, a few experiments and studies on acupuncture may have provided some evidence attesting the validity of the meridian theory. One recent study, for example, may have succeeded in tracing the meridian lines using the "Bi-Digital O-Ring Test" imaging method. This "Bi-Digital O-Ring Test" imaging method has successfully been used to outline the internal organs as well as malignant tumors. In this particular study, while imaging the outline of the internal organs, lines or networks of lines extending from the surface of each organ to other parts of the body were also imaged. These lines closely resemble the meridian lines described by the meridian theory. Hence, the study has also shown that each meridian originates from corresponding internal organs. For example, the "Heart Meridian" originates from, or is connected either directly or indirectly to the heart. Likewise, the "Lung Meridian" corresponds to the lung, the "Kidney Meridian" corresponds to the kidney tissue, the "Pericardium Meridian" corresponds to the adrenal gland, etc. Also during this study, bulging areas of the meridian-like network were imaged at specific locations. These bulging areas were found to correspond to specific acupuncture points. The acupuncture points along a certain meridian line corresponding to a certain defective organ have also been found to have a greater average diameter. These areas returned to normal size/diameter after acupuncture has been performed on certain points along the same meridian.

The quantum electron theory also accounts for the meridian theory. The quantum electron theory claims that there exists a bioplasmic energy, or "life force," that circulates throughout the body, influencing the functioning of the different organs and systems. Research in France and Japan have supported this theory and indicates that this energy can be measured as minute streams of electrons.

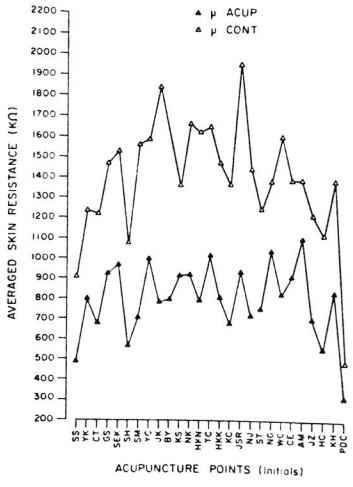
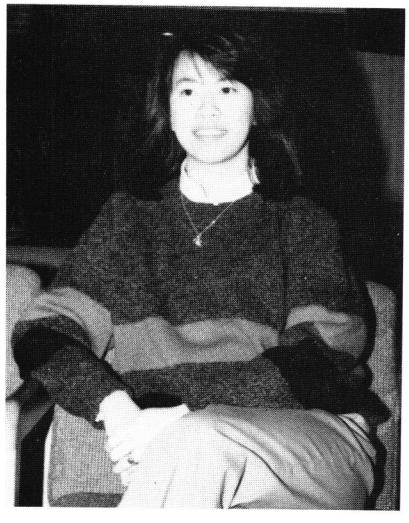


FIG. 4 — Skin Resistance at Acupuncture points and controlled sites.

Despite all the experimental evidence of the existence of the meridian lines, the acupuncture points, and the life force *Qi*, many still reject the meridian theory as well as the entire method of acupuncture. In order for acupuncture to become more understandable and acceptable, much research still needs to be done to help establish a Western neurological basis for acupuncture. In the meantime, why worry about **how** acupuncture works, so long as it works. After all, a patient with an incurable disease will most likely seek almost any means of improving his present condition, disregarding the fact whether those means have a scientific base or not.

Dieu Nguyen is a junior majoring in Computer Engineering. After obtaining her B.S., she plans to work as well as further her studies and try to obtain an M.S. in engineering. She is an active member of both the Eta Kappa Nu and the VSA (Vietnamese Students' Association). In her spare time, she enjoys playing the piano and the violin, as well as writing poetry.



COURTESY OF EULER UY

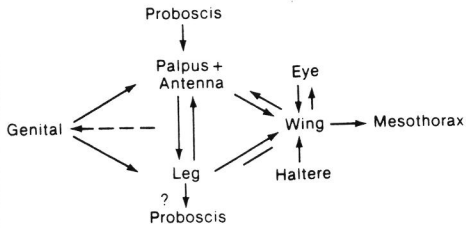
APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY

by Anna Huynh

We are in the beginning stages of perhaps the most profound transition in the history of engineering and genetics - the development and application of recombinant DNA technology, also known as gene splicing or genetic engineering. Although genetic mechanisms such as crossing over can produce recombinant DNA molecules, the term "recombinant DNA" is reserved for the artificial creation of unique DNA segments. Parts of these segments come from different biological sources.

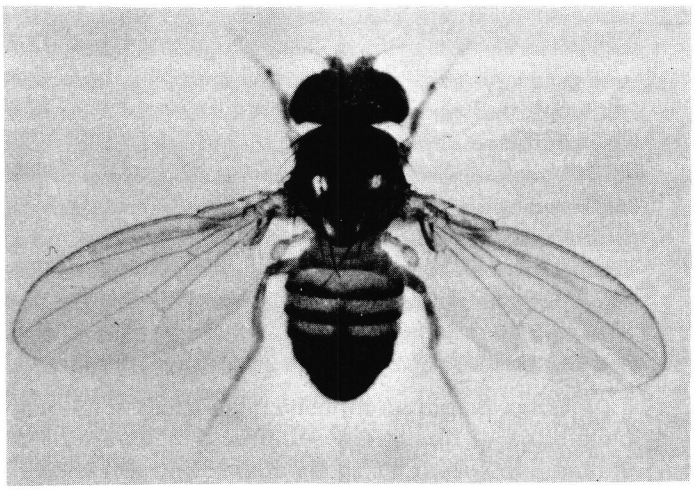
The impact of recombinant DNA technology on areas such as agriculture and the pharmaceutical and chemical manufacturing industries has been astounding. The development of genetic engineering has made it possible to cross species lines in plant genetics. For example, a cloned gene from the bacterium Salmonella that tolerates herbicides, has been transferred to tobacco plants and is being used to transform other crop plants such as cotton, corn, and sunflower. The ability to use a broad spectrum of herbicides to control weeds without damage to crop plants has increased the available supply of plant products.

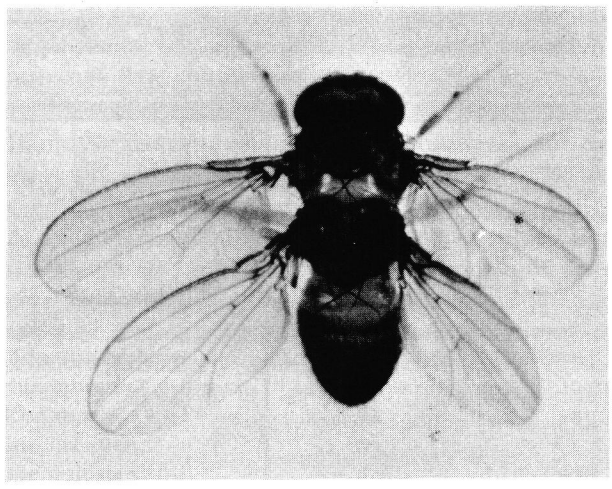
Other advantages in agriculture involve research in increasing the efficiency of photosynthesis and nitrogen fixation. The ability to fix atmospheric nitrogen in biologically useful forms is restricted to certain bacteria and blue-green algae. Some higher plants such as legumes (soybeans, clover and alfalfa) have evolved a symbiotic relationship with nitrogen - fixing bacteria that live in the plant's root modules. These bacteria use energy produced by the host plant to convert atmospheric nitrogen into forms that can be used by the host plant.



— Observed sequence of transdeterminations from each imaginal disk.

Cereal crops such as corn require heavy applications of nitrogen containing fertilizers; a process both inefficient and potentially damaging to the environment. The bacterial genes that regulate the fixation of nitrogen have been isolated and identified. Techniques of genetic engineering will make





Normal fly (left) compared with a fly with two pairs of wings (right) produced by a combination of bithorax mutants.

In industry the processing of agricultural products and the synthesis of many substances require large quantities of microbe-derived enzymes. Even a small increase in of one to two percent in the efficiency of converting starch to dextrose, for example, can be of enormous financial importance. Another possible use of recombinant DNA technology is in the manufacturing of certain bulk chemicals, including methanol, ethanol, and acetone, through the breakdown of cellulose - containing plant waste products by genetically engineered bacteria and yeasts. Obviously, this technology is important in the production of medicines, most of which are difficult to obtain because they are produced in small quantities in the cell. The most profound effects of genetic engineering is on the diagnosis and treatment of genetic diseases in humans. Research is done to produce inexpensive and reliable vaccines against such major infectious diseases as hookworm, which is a potentially fatal parasitic disease that affects 900 million people worldwide.

As a sidelight, a very interesting experiment which is indirectly related to recombinant DNA involves transdetermination of imaginal disks in the larva of the common fruit fly. Imaginal disks are discrete groups of cells set aside during the larval stage in some insects. These disks, formed from hollow sacs of cells, are determined to form specific parts of the adult body. For instance, there are eye-antennal disks, leg disks, wing disks, and so forth. During metamorphosis, most of the body parts of the larva break down, and the imaginal disks differentiate into adult structures of the head, thorax, and abdomen. In transdetermination, an imaginal disk can be explanted from the larva and implanted into the abdomen of an adult. During the early transfers, the disk always maintains its determined state following experimental manipulation, meaning a leg disk always differentiates into a leg structure,etc. After several passages through adult abdomens, atypical structures were occasionally discovered, that is, an antennal disk sometimes produced wing structures, and so forth.

The major forms of transdetermination are summarized in figure . All disks can be transdetermined into one or another disk type. There are certain sequences of transdetermination; for example, not all structures can produce a leg.

Transdetermination shows many of the properties of homoeotic mutants, which are mutations of genes in DNA, that determine the developmental fate of cells in an individual segment. Thus the mutant tumorous head transforms the head into the last abdominal segment and genitalia.

No unique DNA parts are created in transdetermination and homoeotic mutants. A homoeotic mutant, however, and transplantation experiments in transdetermination may give rise to peculiar looking insects with body parts in locations different than those of ordinary insects.

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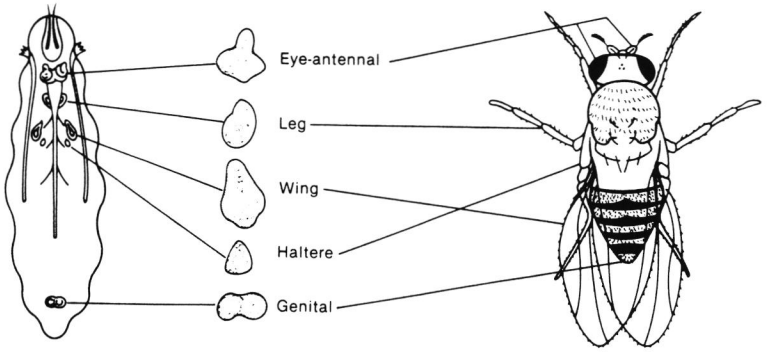
COURTESY OF GEORGE CHAR

Ha T. Huynh, a sophomore EE major, is a transfer student from Virginia Tech. During the previous summers she has worked for Computer Sciences Corporation and the U.S. Postal Service. She enjoys helping to coordinate the GW Community Action Ne t work (GWCAN) volunteer drive and being a member of the Pre-Med Society. After obtaining a BS degree, Ha aims to continue her education in medical school.

Investigation of abnormalities caused by mutations often provides insight into the function of the normal gene during development. Experiments in developemental genetics and in gene splicing are valuable aids in understanding how we and all living organisms come to exist. □



Imaginal disks of the Drosophila larva and the adult structures derived from them.

COURTESY OF CONCEPTS OF GENETICS

MEDICINE AND WORKING

by Rose Province

A patient lies prone on the hospital bed, as a doctor waves a long rod slowly across the patient's body. His vital statistics, blood counts, and diagnosis are immediately determined and printed on a computer printout.

No, the preceding paragraph was not reality,but it could be a scene in the hospital of the future. But not too far into the future, with the help of people like Robert Howard , the director of Biomedical Engineering at Children's Hospital in D.C. Mr. Robert Howard did IEEE's Biomedical Engineering Society the honor of being their guest speaker this fall.

The biomedical engineering department at Childrens Hospital is 10 years old. It is a small department, consisting of only four technicians and two engineers, but a very integral part of the hospital's function. This, one can clearly see as they accompany Robert Howard on a tour through the hospital facility.

A number of important functions are provided by the Biomedical engineering department at C.H. that aren't strictly engineering. One is preventive maintenance, an important but time consuming function, necessary to keep the life saving equipment in working order. The department also has a well organized scheme of computerized record keeping, that includes a master list of all equipment and records of all maintenance. In addition, the department must be familiar with all medical devices on the market, and put them through extensive testing before they are put into service at the hospital. Once the new equipment is bought, all nurses and staff must be trained in the operation of the equipment. Without this training the equipment would be useless, and much time would be wasted.

A large part of the engineering work at Children's Hospital involves adapting adult medical equipment to the smaller size of children and infants.

System Integration is also an important job of the engineers in the department. This involves grouping a number of instruments into a compact, space saving, efficient system. An example of this is a mechanism the department designed for transporting infants. This system includes an incubator, to control the temperature environment of the baby, a physiological monitor (monitors pulse, breathing, blood pressure, oxygenation of blood etc.),a ventilator, oxygen, and air compressor, all on an ambulance base for easy transport.

At birth infants may intake the birth fluid of the uterus, thus filling up their lungs and suffocating them. But biotechnology has saved many infants lives with the creation of the Extra Corporial Membrane Oxygenation machine(ECMO), or the bypass pump. This is an electromechanical device that removes blood, circulates it, and oxygenates it, also allowing measurement of oxygen, carbon-dioxide and PH. This machine does the breathing for the infant until their lungs dry out and they are able to breath on their own. A decoagulent chemical is used in the mechanism, the levels of this chemical are high enough that it can cause hemorrhaging in the brain of very small infants. A mechanism is being worked on that would decrease the chemical level needed for operation.

The newest goal in medicine

COURTESY OF ROBERT HOWARD

Since there is no maternity ward at the Children's Hospital, all infant patients are transported in. Without this Mobile Intensive Care unit, a product of the Biomedical Engineering Dept., the trip would be very difficult. The module shown is land based, however, a more trimmed down version is for air travel.

TECHNOLOGY TOGETHER

COURTESY OF ROBERT HOWARD

A close view shows the efficient design of the transport unit. A couple of IV pumps are stationed toward the front, and tubes run to the model infant's mouth from the ventilator, which is controlled from the front panel. All cables, involving EKG monitoring and temperature control run internally, so they do not get pulled and tangled on the outside.

technology is to design devices that are "non-invasive", devices that can take measurements without invading the body. An excellent tool that demonstrated this is the *Pulse Oximeter*. This device measures light absorption through the finger, to determine how well oxygenated the blood is. This is possible because oxygenated hemoglobin picks up a different wavelength of light than hemoglobin that is not carrying oxygen. This device also senses heart rate and strength of pulses, and is used in intensive care and O.R.

There are also many devices being designed that make a nurses life easier. Such as the automatic blood pressure device, which does away with the stethoscopes. A cuff senses pressure pertibation as blood starts pulsing through the vessels. The device can be programmed to gauge blood pressure at timed intervals, freeing the nurse of this task.

Microprocessor based patient monitoring systems used in intensive care are very impressive. CRT displays are at every bedside, displaying the patient's vital statistics, and in addition there is a nurses' station that allows one to switch to view any display in the room, or four at a time, windowed on the screen.

According to Robert Howard, OR lasers are a very hot item in the medical engineering field. There are a wide range of applications for surgical lasers, these include cutting, coagulation, and denaturization of tissue. Lasers can be used to disrupt tissue by *Chemical Bond Breakage* or *Thermal Ablation*. Chemical bonds are broken by the high photon energies of the laser beam, or multiple photon interactions. While thermal ablation utilizes extremely rapid heating during which thermodynamic equilibrium is not maintained. This results in very high local tissue pressure, along with rapid vaporization and structural changes in the tissue.

At power densities too low to result in temperatures above the damage threshold over ordinary activation times, laser sources are used to activate photosensitive drugs for tumor or arterial plaque identification or destruction or both.

The essential feature that allows lasers to cut is the highly localized damage, with minimal damage to surrounding tissues. Lasers with high photon energies can break molecular bonds.

Another function of the laser is tissue coagulation, or bonding of tissue structures, as in vessel welding. This involved agglutinization of protein to provide sealing with no over all disruption of tissue structure. The target is the protein collagen, this protein forms a "glue" between ends of severed vessels.

The instruments mentioned in the article are just a drop in the bucket, compared to the vast ocean of applications for engineering in medicine. Biomedical Engineering is the field of the present and the future. It combines two disciplines, seemingly diverse, one very human, and one technical, and in doing so provides exciting challenges to engineers and doctors to learn more, create more, and save more lives.

Rose Province, majoring in EE-premed, is currently a co-op student at NASA in Greenbelt,MD. She serves as co-editor for MECHELECIV, is a member of Tau Beta Pi engineering honor society, IEEE's Bio-Medical Engineering Society, and is vice president of Eta Kappa Nu.

Excellence In Co-ops Recognized

Excellence in The George Washington University's (GWU's) Cooperative Education Program in Engineering was evident again in 1987 when Gayle Tyson and Anaed Zaragoza, two of GWU's co-op students, received distinguished honors.

Gayle Tyson, a senior electrical engineering major, became the recipient of three awards: the GWU Cooperative Education Employee of the Year Award (1986-87), the Xerox Technical Minority Scholarship, and the National Association of Minority Engineering Program Administrators (NAMEPA) Region A Merit Scholarship. The GWU Co-op Employee of the Year Award, presented annually by GWU's Cooperative Education Office directed by Mr. Howard Davis, is based on the student's job performance, academic record, and extracurricular participation. Tyson received this award at the National Capital Association for Cooperative Education (NCACE) Student Recognition Luncheon on June 4, 1987. Also in 1987, Xerox endowed its $3000 Technical Minority Scholarship to Tyson for the second time. Finally, the $750 NAMEPA Merit Scholarship received by Tyson in 1987 is based on academic achievement and exemplary community and engineering-related student activity involvement.

Tyson, a native and citizen of Kingston, Jamaica, secured her co-op position not through the usual process via GWU's Cooperative Education Office, but on her own while seeking summer employment. After mailing resumes to various companies and making numerous telephone calls to Xerox Corporation, Tyson's search for summer employment resulted in a co-op position at Xerox's office in Rochestor, New York.

Tyson recalled her co-op experience as "the best thing I ever did pertaining to my education." She elaborated by noting the practical experience that working as a co-op student provided her. Among her tasks at Xerox were isolating and correcting hardware and software errors and writing

COURTESY OF EULER UY

software code to perform testing of input/output (I/O) interfaces for Intel 8085-based systems. Since Xerox stressed a 'do until done' attitude, Tyson's work week averaged about fifty-five hours. However, Xerox did not overtly emphasize maintaining high grades. Moreover, cooperative education gave Tyson a chance to anticipate the change in environment from GWU to Xerox and vice versa.

Back at school, in addition to her regular academic load, Tyson participated in the honors research program. Her campus affiliation included being the vice-president of GWU's chapter of the National Society of Black Engineers (NSBE), the vice-president of the Caribbean Student Association, a member of Eta Kappa Nu, and a jazz acappella singer in the GW Troubadours. Tyson also enjoyed writing letters to her dozen pen pals throughout the world.

Tyson has fulfilled her co-op obligation and is completing her final semester at GWU. For the next phases in her career, Tyson is interested in very large scale integration (VLSI) design and technical management. Tyson especially respects engineers who are extremely knowledgeable designers and those who are inspiring managers. Tyson recommends cooperative education to all students, and specifically that students obtain diverse experiences by working for more than one company.

Anaed Zaragoza, a junior computer science major, received an official commendation and a $250 award from the U.S. Department of the Army on September 3, 1987 for her exceptional performance during her co-op block from January to August 1987 at the U.S. Army Concepts Analysis Agency (CAA) in Bethesda, Maryland.

During the aforementioned co-op block, Zaragoza worked on two projects that led her commendation. Both projects required coding software using the 'C' computer language. So Zaragoza had to learn 'C' prior to starting her first project which was to establish a means to

access a Sony Graphover laser disc map projection system which CAA had purchased. Upon completion, Zaragoza had designed, implemented, and documented original software that enabled CAA to use such a means of access. For her second project, Zaragoza developed an expert system based logistical resupply software module that manages and coordinates resupply logistics for the CAA's Contingency Force Analysis Wargame.

Zaragoza, a native of Puerto Rico, came to the U.S. mainland on vacation almost four years ago, but instead of returning home, she enrolled at GWU. Unlike Tyson's interview with Xerox, GWU's Cooperative Education Office did arrange Zaragoza's interview with CAA. CAA hired Zaragoza on the same day as her interview.

Zaragoza definitely recommends cooperative education to her fellow students. Zaragoza views cooperative education as an enhancement to classroom instruction, valuable work experience, and an opportunity to work along side engineering professionals. Zaragoza describes her supervisor as very friendly and congenial. Once a month, Zaragoza and her supervisor would have lunch together to discuss her progress. Also once every month, there would be a meeting with all the co-op students and their directorates within CAA.

Zaragoza plans to complete her co-op obligation with CAA and receive her Bachelor of Science degree from GWU in May 1989. Attending graduate school is one possibility Zaragoza is considering.

— Ka P. Lee

Discrepancy Between Tuition Rates Challenged

The following article contains quoted excerpts from SEAS Senator Malik's Tuition Rates Reform Resolution. MECHELECIV does neither approve nor reject the Resolution. A complete copy of the Resolution may be obtained from either GWUSA or the Engineers' Council.

— Ka P. Lee, Campus News Editor

On November 10, 1987, Senator Nadeem Pasha Malik of the School of Engineering and Applied Science (SEAS) proposed his Tuition Rates Reform Resolution to the George Washington University Student Association (GWUSA). The Resolution describes the discrepancy between tuition rates paid by SEAS and by non-SEAS GWU students. Specifically, the tuition rate paid by a GWU student is not determined by the school (e.g., SEAS, Columbian, etc.) in which he/she takes a certain course, but by whether he/she is registered as a SEAS or non-SEAS student. In other words, SEAS charges the higher SEAS tuition rate regardless of whether or not a SEAS student is enrolled in a SEAS course. Frequent readers of MECHELECIV would recall that a letter to the editor of MECHELECIV in fall of 1984 by Gyanchander Gongireddy addressed this previous point. According to Malik in his Resolution, "nearly a quarter of a million dollars (excess, -ed.) dollars a year SEAS collects from its students only because their division happens to be 03 (SEAS, *ed.*) instead of 01 (non-SEAS, *ed.*)." In his Resolution, Malik proceeds to resolve the following:

- All SEAS students taking courses outside the SEAS must NOT be charged the SEAS rates for NON-SEAS courses.
- Everyone taking a 'xyz' course in 'xyz' college should pay the tuition and fees according to its rate.
- Computer fees should not be automatically required of SEAS students for courses that **may** require university computer usage.
- Computer fees for the courses requiring computer usage should be left as an option for the student to decide if he/she would want a GWU computer account.

Malik concludes the following:

- Some students already have access to computer outside the university and have no need for a GWU account.
- Few SEAS students are aware of the tuition rate difference between colleges at GWU.
- It is a fact that anyone enrolled in a different college can earn many credits in the School of Engineering and Applied Science without being enrolled in SEAS.
- A student could earn a degree from SEAS if he/she follows the SEAS curriculum and transfer to SEAS and take only the last 30 hours at SEAS before graduating.
- Best of all, a student could save nearly $3500 (at current tuition rates) by the time he/she graduates.

continued on page 16

Continued from page **15**

As expected, the reaction to the Resolution is split between students and administrators. The student organizations that have approved the Resolution include GWUSA, GWU's Engineers' Council, GWU's student branch of the Institute of Electrical and Electronic Engineers (IEEE), and Tau Beta Pi. In a meeting on December 3, 1987 between Senator Malik and SEAS administrators Dean Liebowitz, Associate Dean Feir, and Research and Resources Office Director McIntyre, the SEAS administration dismissed the Resolution, but encouraged Malik to address his Resolution to the GWU administration. From students' point of view, the last word on the Tuition Rates Reform Resolution is yet to be spoken. However, any resolution passed by GWUSA is non-binding on the GWU administration.

— Ka P. Lee

Ka Lee is entering his senior year as an EE major. Among Ka's ambitions are becoming a communications engineer and leaving his mark on society. Currently, Ka serves as Campus News editor for MECHELECIV, president of Eta Kappa Nu, secretary of GWU's Engineering Council, and treasurer of Tau Beta Pi and Omega Delta Kappa. Ka enjoys the nuances of consciousness.

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